

WHAT IS CLAIMED IS:

1. A method of forming a thin film, comprising: an intermediate thin film forming step of sputtering a target comprising a single type or a plurality of types of metals to form an intermediate thin film comprising the metal or an incomplete reactant of the metal onto a substrate; a film composition converting step of bringing the formed intermediate thin film into an active seed of a reactive gas mixed with an inactive gas having a chemically inactive property in such a manner that the intermediate thin film is reacted with the active seed of the reactive gas, and converted into a compound of the metal; and an optical characteristic adjusting step of repeatedly conveying a substrate holder between a zone to perform the intermediate thin film forming step and a zone to perform the film composition converting step while controlling a conveying speed of the substrate holder for holding the substrate, repeatedly performing the intermediate thin film formation and the film composition conversion, and accordingly adjusting a film composition of a finally formed thin film to form the thin film having an optical characteristic value of a region where a hysteresis phenomenon occurs in which a change route of the optical characteristic value differs with a reactive gas flow rate in a case where a flow rate of the reactive gas is increased and a case where the flow rate is decreased.

2. The thin film forming method according to claim 1, wherein the optical characteristic adjusting step comprises the steps of: rotating/driving the substrate holder holding the substrate on an outer peripheral face  
5 and having a cylindrical or hollow polygonal columnar shape; and controlling a rotation speed of the substrate holder to form the thin film having the optical characteristic value in the region where the hysteresis phenomenon occurs.

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3. The thin film forming method according to claim 1, wherein the region where the hysteresis phenomenon occurs is a region of the optical characteristic value of the thin film formed when the reactive gas introduced in  
15 performing the sputtering has a flow rate of 15 sccm or less, which does not include 0 sccm.

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4. A thin film forming apparatus comprising: a substrate holder which is disposed in a vacuum tank and  
20 which holds a substrate; a film formation process zone which is disposed in the vacuum tank and in which sputtering is performed with respect to a target comprising a single type or a plurality of types of metals to form an intermediate thin film on the substrate; a reaction process  
25 zone comprising active seed generating means for generating an active seed of a reactive gas, and disposed in the vacuum tank, in which the intermediate thin film is reacted

with the active seed of the reactive gas to form a thin film; partitioning means for spatially separating the film formation process zone and the reaction process zone from each other; substrate holder driving means for driving the  
5 substrate holder in order to convey the substrate between a  
position facing the film formation process zone and a position facing the reaction process zone; and substrate holder conveying speed controlling means for controlling the substrate holder driving means in a range configured to  
10 form the thin film having an optical characteristic value in a region where a hysteresis phenomenon occurs in which a change route of the optical characteristic value differs with respect to a reactive gas flow rate in a case where the flow rate of the reactive gas is increased and in a  
15 case where the rate is decreased.

5. The thin film forming apparatus according to claim 4, wherein the region where the hysteresis phenomenon occurs is a region of the optical characteristic value of  
20 the thin film formed when the reactive gas introduced in performing the sputtering has a flow rate of 15 sccm or less, which does not include 0 sccm.